Fermilab — Fermi National Accelerator Laboratory

Technical Division-Machine Shop

Procedure Qualification Record No. Fermi PQR Ti-4 | Date 12/29/2008

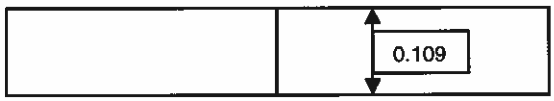
Revision: 1 Date: 1/08/09 Remarks: Revised to correct clerical errors
Revision: 2 Date: 2/4/09 Remarks: Revised Voltage and Test ID # to 1215-008/01
Revision 3 Date: 6/17/09 Remarks: Added tungsten requirements

Welding Process/Weld Type: *GTAW/Automatic* | Supporting WPS: ***Fermi WPS Ti-4***

Joints (QW-402) **Details:**

Weld Type:	*Square Butt Groove Weld*
Backing:	*Gas Backing Only*
Root Opening:	*0.00 to 0.002 Maximum*
Root Face:	*Tube or Pipe Thickness*

1.5" diameter ASTM B861 Grade 2 Titanium
No filler (Autogenous) Single Pass with AMI Orbital Welding Machine 227



Base Metals (QW-403)
Material Spec., Type or Grade
ASTM B861, Grade 2 to *ASTM B861, Grade 2*
P-No. *51* to **P-No.** *51*
Thickness of Coupon (in.) *0.109 inches*
Diameter of Test Coupon (in.) *1.5 inches*

Post Weld Heat Treatment (QW-407)
Type: *No PWHT performed*
Temperature: *None*
Time: *None*

Filler Metals (QW-404) *None (Autogenous)*
SFA Specification:
AWS Classification:
Filler Metal F-No.:
Weld Metal Analysis A-No.:
Size of Filler Metal (in.):
Weld Deposit "t"(in.):

Gas (QW-408)

	Gas	Mixture%	Flow Rate
Shielding:	*Argon*	*>99.995%*	*@ 30 CFH*
Trailing:		*None*	
Backing:	*Argon*	*>99.995%*	*@ 10 to 30 CFH*

Other: *Closed Chamber welding head*

Positions (QW-405)
Position of Joint: *6G*
Weld progression: *Upward and Downward*

Preheat (QW-406)
Preheat Temperature: *Ambient 66° F*
Interpass Temperature: *350° F Maximum*

Electrical Characteristics (QW-409)
Current/Polarity: *DCEN (Straight)*
Tungsten Type & Size: *EWCe-2* *3/32 diameter*
Volts: 10-15
Amps, Pulse: *See Sequence Chart*

Technique (QW-410)
Travel (ipm): *As Required* **Oscillation:** *None*
String/Weave Bead: *Stringer*
Multiple/Single Pass (per side) *Single*
Multiple/Single Electrode: *Single Electrode*

Sequence Chart *AMI Orbital Welding Machine Model 227 with Model 8-4000 Welding Head Closed Chamber*
Mfg. shaped & sized tungsten required

Weld Levels	Pulse	Rotation	RPM Primary IPM	RPM Back IPM	Time sec	AMPS Primary	AMPS Back	PULSE Primary Per sec	PULSE Back Per sec	Other Requirements
1	ON	Continuous	0.20	---	15	116	50	0.40	0.30	Voltage set by Mfg. Mfg. pre-ground/pre-shaped and sized tungsten required. Mfg. part # TC09-1635-04 Arc gap set at .070 in.
2	ON	Continuous	0.30	---	62	115	50	0.40	0.30	
3	ON	Continuous	0.30	---	62	121	50	0.40	0.30	
4	ON	Continuous	0.30	---	33	119	50	0.40	0.30	
5	ON	Continuous	0.30	---	36	115	50	0.40	0.30	
6	ON	Continuous	0.30	---	46	113	50	0.40	0.30	

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Tensile Test (QW-150)

Specimen No.	Width (in.)	Thickness (in.)	Area (Squared in.)	Ultimate Total Load (lbs.)	Ultimate Stress (PSI)	Failure Type & Location
1	*0.504*	*0.110*	*0.0554*	*3,483*	*62,825*	*Ductile-WM*
2	*0.505*	*0.108*	*0.0545*	*3,629*	*66,538*	*Ductile-WM*

Guided Bend Test (QW-160)

Figure Number & Type	Result	Figure Number Type	Result
QW-462.3 (a) Face Bend	***Acceptable***	QW-462.3 (a) Root Bend	***Acceptable***
QW-462.3 (a) Face Bend	***Acceptable***	QW-462.3 (a) Root Bend	***Acceptable***

Visual Examination: *Acceptable*	**X-ray per ASME Section IX, QW-191.2.2** *None*

Welder's Name: *Michael P. Reynolds* **ID #** *03993N* **Weld Stamp #** *9*

Welding of coupon Verified by: *Roger Hiller ID # 00362N* 

Mechanical Tests Conducted by: *Bodycote Testing Group* **Test ID#:** *1215-008/01*

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler & Pressure Vessel Code.

PQR prepared by: ***Fermi National Accelerator Laboratory***

Authorized Representative  ID# 00362N